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2014 Jan C34

2	$\dfrac{\tan 2x + \tan 50°}{1 - \tan 2x \tan 50°} = 2 \Rightarrow \tan(2x + 50°) = 2$ $\Rightarrow 2x + 50° = 63.43°, (243.43°, 423.43°)$ $\Rightarrow x =$ awrt $6.72°$ or $96.72°$ or $186.72°$ $\Rightarrow 2x + 50° = 243.43°\ (423.43°) \Rightarrow x = ..$ $x =$ awrt $6.72°, 96.72°, 186.72°$	M1A1 dM1, A1 dM1 A1 **(6 marks)**
8 (a)	$2\text{cosec}2A - \cot A = \dfrac{2}{\sin 2A} - \dfrac{1}{\tan A}$ $\quad 2\,\text{cosec}2A = \dfrac{2}{\sin 2A}$ $= \dfrac{2}{2\sin A\cos A} - \dfrac{\cos A}{\sin A}$ $= \dfrac{2 - 2\cos^2 A}{2\sin A\cos A}$ $\dfrac{2(1-\cos^2 A)}{2\sin A\cos A} = \dfrac{2\sin^2 A}{2\sin A\cos A} = \dfrac{\sin A}{\cos A} = \tan A$	B1 M1 M1 A1* **(4)**
(b)(i)	$2\text{cosec}4\theta - \cot 2\theta = \sqrt{3} \Rightarrow \tan 2\theta = \sqrt{3}$ $\Rightarrow \theta = \dfrac{\arctan\sqrt{3}}{2} = \dfrac{\pi}{6}$ $\quad$ Accept awrt 0.524	M1 A1
(ii)	$\tan\theta + \cot\theta = 5 \Rightarrow \text{cosec}2\theta = \dfrac{5}{2}$ $\Rightarrow \theta = \dfrac{1}{2}\arcsin\left(\dfrac{2}{5}\right) =$ awrt $0.206, 1.37$	M1 dM1A1A1 **(6)** **(10 marks)**

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13. (a)	$R = \sqrt{5} = 2.23606...$ (must be given in part (a))	B1
	$\tan\alpha = \frac{1}{2}$ or $\sin\alpha = \frac{1}{\sqrt{5}}$ or $\cos\alpha = \frac{2}{\sqrt{5}}$ (see notes for other values which gain M1)	M1
	$\Rightarrow \alpha = 26.56505...^\circ$ (must be given in part (a))	A1 **[3]**
(b)	Way 1: Uses distance between two lines is 4 (or half distance is 2) with correct trigonometry **may** state $4\sin\theta + 2\cos\theta = 4$ **or** show sketch	M1
	Need sketch **and** $4\sin\theta + 2\cos\theta = 4$ **and** deduction that $2\sin\theta + \cos\theta = 2$ or $\cos\theta + 2\sin\theta = 2$ *	A1 * **[2]**
	Way 2: **Alternative method:** Uses diagonal of rectangle as hypotenuse of right angle triangle and obtains $\sqrt{20}\sin(\theta + \alpha) = 4$	M1
	So from (a) $2\sin\theta + \cos\theta = 2$ or $\cos\theta + 2\sin\theta = 2$	A1 **[2]**
	Way 3: They may state and verify the result provided the work is correct and accurate See notes below. **Substitution of 36.9** (obtained in (c) is a circular argument and is **M0A0**)	
(c)	Way1: Uses $\sqrt{5}\sin(\theta + 26.57) = 2$ to obtain $\sin(\theta + "26.57") = \frac{2}{"\sqrt{5}"}$ $(= 0.8944...)$ $\theta = \arcsin\left(\frac{2}{\text{their } "\sqrt{5}"}\right) - "26.57"$ Hence, $\theta = 36.8699...^\circ$	Way 2 $\cos^2\theta + 4\cos\theta\sin\theta + 4\sin^2\theta = 4$ See notes for variations $4\cos\theta\sin\theta - 3\cos^2\theta = 0$ $\cos\theta(4\sin\theta - 3\cos\theta) = 0$ so $\tan\theta = \frac{3}{4}$ $\theta = \arctan\frac{3}{4}$ or equivalent M1 M1 A1 **[3]**
(d)	Way 1: $"x" = \frac{2}{\tan"36.9"}$ $\{h + x = 4 \Rightarrow\}$ $h + \frac{2}{\tan"36.9"} = 4$ $h = 4 - \frac{2}{\tan 36.9} = 1.336...$ or $\frac{4}{3}$ or $\underline{1.3}$ (2sf)	Way 2: $"y" = \frac{4}{\sin\theta}$ $\{h + y = 8 \Rightarrow\}$ $h + \frac{4}{\sin"36.9"} = 8$ $h = 8 - \frac{4}{\sin 36.9} = \frac{4}{3}$ or $\underline{1.3}$ (2sf) B1 M1 A1 cao **[3]**
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2	$2\cos 2\theta = 5 - 13\sin\theta \Rightarrow 4\sin^2\theta - 13\sin\theta + 3 = 0$ $\Rightarrow (4\sin\theta - 1)(\sin\theta - 3) = 0$ $\sin\theta = \frac{1}{4}$ θ = awrt 0.253, 2.889 (3dp)	M1A1 M1 A1,A1 cso **(5 marks)**

7(a)	$2\cos(x+30)° = \sin(x-30)°$ $2(\cos x°\cos 30° - \sin x°\sin 30°) = \sin x°\cos 30° - \cos x°\sin 30°$ $2\cos 30° - 2\tan x°\sin 30° = \tan x°\cos 30° - \sin 30°$ $\sin 30° = \frac{1}{2}, \quad \cos 30° = \frac{\sqrt{3}}{2}$ $\tan x° = \frac{2\sqrt{3}+1}{\sqrt{3}+2} \Rightarrow \times \frac{\sqrt{3}-2}{\sqrt{3}-2} \Rightarrow \tan x° = 3\sqrt{3} - 4$	M1A1 B1 dM1A1* **(5)**
(b)	$\tan(2\theta + 10)° = 3\sqrt{3} - 4$ $2\theta + 10 = 50.1, (230.1) \Rightarrow \theta = ..$ θ = 20.1, 110.1	M1 dM1 A1,A1 **(4)** **(9 marks)**

13(a)	$R = \sqrt{109}$	B1
	$\tan\alpha = \frac{3}{10} \Rightarrow \alpha = \text{awrt}\, 16.70°$	M1A1
		(3)
(b)(i)	Max height = 12+ '$\sqrt{109}$' = 22.44 m	M1A1
(ii)	Occurs when $30t + '16.70' = 180 \Rightarrow t = 5.44$	M1A1
		(4)
(c)	$18 = 12 - \sqrt{109}\cos(30t + 16.70) \Rightarrow \cos(30t + 16.70) = -\frac{6}{\sqrt{109}}$ $(-0.57..)$	M1A1
	$\Rightarrow 30t + 16.70 = \text{arc}\cos\left(-\frac{6}{\sqrt{109}}\right) \Rightarrow t = ..$	dM1
	$t = \text{awrt}\ 3.61\,(2\text{dp})$	A1
		(4)
(d)	Attempting $30t = 360 \Rightarrow t = ..$ or $30t = 720 \Rightarrow t = ..$	M1
	2 revolutions in 24 **minutes**	A1
		(2)
		(13 marks)

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7(a)	$4\tan 2x - 3\cot x \sec^2 x = 0 \Rightarrow 4\times\frac{2t}{1-t^2} - 3\times\frac{1}{t}\times(1+t^2) = 0$	B1M1A1
	So $4\times 2t^2 - 3\times(1+t^2)(1-t^2) = 0$ and $3t^4 + 8t^2 - 3 = 0$ *	A1*
		(4)
(b)	$3t^4 + 8t^2 - 3 = 0 \Rightarrow (3t^2 - 1)(t^2 + 3) = 0$ so $t =$	M1
	$\tan x\,(t) = \pm\frac{1}{\sqrt{3}}$ *or* ± 0.5774	A1
	$x = \frac{\pi}{6}, \frac{7\pi}{6}, \frac{5\pi}{6}, \frac{11\pi}{6}$	M1A1
		(4)
		(8 marks)

11(a)	$(R = \sqrt{1.5^2 + 1.2^2}) =$ awrt 1.921 - accept e.g. $\sqrt{3.69}$ or $\frac{3\sqrt{41}}{10}$	B1
	$\tan\alpha = \frac{1.2}{1.5} \Rightarrow \alpha = 0.675$ or 0.215π	M1A1
		(3)
(b)	$H = 3 + 1.921\sin\left(\frac{\pi t}{6} - 0.675\right)$	
	$H_{\min} = 3 - '1.921' =$ awrt 1.08	M1A1
	$\left(\frac{\pi t}{6} - "0.675"\right) = \frac{3\pi}{2} \Rightarrow t = 10.29$	M1A1
		(4)
(c)	$4 = 3 + 1.921\sin\left(\frac{\pi t}{6} - 0.675\right) \Rightarrow \sin\left(\frac{\pi t}{6} - 0.675\right) = \frac{1}{1.921}$	M1
	$\frac{\pi t}{6} - 0.675 = 0.548 \Rightarrow t =$ awrt 2.33 or 2.34	dM1A1
	$\frac{\pi t}{6} - 0.675 = \pi - 0.548 = 2.594 \Rightarrow t =$ awrt 6.24 or 6.25	ddM1A1
	Times are 2:20pm and 6:15pm or 6.14pm (14:20 and 18:15 or 18:14) – allow 2 hours 20minutes and 6 hours 15 or 14minutes or 140 minutes and 375 or 374 minutes	A1
	Extra values in the range – lose final A mark.	**(6)**
		(13 marks)

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2 (a)	$\text{cosec}^2 x - \text{cosec}x - 12 = 0$ or $k = -12$	B1 [1]
(b)	$\text{cosec}^2 x - \text{cosec}\, x - 12 = 0$ so $(\text{cosec}x - 4)(\text{cosec}x + 3) = 0 \Rightarrow \text{cosec}x = ...$	M1
	$\sin x = \frac{1}{4}$ or $-\frac{1}{3}$	dM1
	$\Rightarrow x = 14.5°$ or $165.5°$ or $340.5°$ or $199.5°$	dM1, A1 A1 [5] **(6 marks)**

8(a)	**Either** $f(\theta) = 9\cos^2\theta + \sin^2\theta = 9\cos^2\theta + 1 - \cos^2\theta$	M1
	$= 8\cos^2\theta + 1 = 8\frac{(\cos 2\theta + 1)}{2} + 1$	M1
	$= 5 + 4\cos 2\theta$	A1 [3]
	Or $f(\theta) = 9\frac{(\cos 2\theta + 1)}{2} + 1\frac{(1 - \cos 2\theta)}{2}$	M1 M1
	$= 5 + 4\cos 2\theta$	A1 [3]

10. (a)	$R = \sqrt{34}$		B1
	$\tan\alpha = \frac{5}{3}$		M1
	$\Rightarrow \alpha = 1.03$	awrt 1.03	A1 [3]
(b)	$3\sin 2x + 5\cos 2x = 4 \Rightarrow \sqrt{34}\sin(2x + 1.03) = 4$		
	$\sin(2x + "1.03") = \frac{4}{"\sqrt{34}"}$ $(= 0.68599...)$		M1
	One solution in range Eg. $2x + "1.03" = 2\pi + \arcsin\left(\frac{4}{"\sqrt{34}"}\right) \Rightarrow x = ...$		M1
	Either $x =$ awrt 3.0 **or** awrt 0.68		A1
	Second solution in range Eg $2x + "1.03" = \pi - \arcsin\left(\frac{4}{"\sqrt{34}"}\right) \Rightarrow x = ...$		M1
	Both $x =$ awrt 2sf 3.0 **and** 0.68		A1 [5]
(c)	Greatest value is $4\left(\sqrt{34}\right)^2 + 3 = 139$		M1 A1
	Least value is $4(0) + 3 = 3$		M1 A1 [4] **(12 marks)**

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1.(a)	$R = \sqrt{34}$	Cao (Must be exact but score when first seen and ignore decimal value (5.83…))	B1
	$\tan\alpha = \pm\frac{5}{3}$, $\tan\alpha = \pm\frac{3}{5} \Rightarrow \alpha = ...$ (Allow $\cos\alpha = \pm\frac{5}{\sqrt{34}}$ or $\pm\frac{3}{\sqrt{34}}$, $\sin\alpha = \pm\frac{5}{\sqrt{34}}$ or $\pm\frac{3}{\sqrt{34}} \Rightarrow \alpha = ...$) Where $\sqrt{34}$ is their R		M1
	$\alpha = 59.04°$	awrt 59.04°	A1
			(3)
(b)	$\sqrt{34}\cos(\theta - 59.04) = 2 \Rightarrow \cos(\theta - 59.04) = \frac{2}{\sqrt{34}}(0.343)$ Attempts to use part (a) "$\sqrt{34}$" $\cos(\theta -$ "59.04") $= 2$ and proceeds to $\cos(\theta \pm$ "59.04") $= K$, $\lvert K\rvert$ „ 1 May be implied by $\theta -$ "59.04" $= 69.94…°$ or $\theta -$ "59.04" $\cos^{-1}\left(\frac{2}{\text{their}\sqrt{34}}\right)$ The $\theta -$ "59.04" must be seen here or implied later		M1
	$\theta_1 - 59.04 = 69.94 \Rightarrow \theta_1 =$ awrt 129.0°		A1
	$\theta_2 \pm 59.04 = 360 - '69.94' \Rightarrow \theta_2 = ...$ Correct attempt at a second solution in the range. It is **dependent** upon having scored the previous M. Usually for $\theta -$ their $59.04 = 360 -$ their $'69.94' \Rightarrow \theta = ...$		dM1
	$\theta_2 = 349.1°$	awrt 349.1°	A1
	For solutions in (b) that are otherwise fully correct, if there are extra answers in range, deduct the final A mark.		
			(4)
(c)	$\theta +$ their $59.04 = \cos^{-1}\left(\frac{2}{\text{their}\sqrt{34}}\right) \Rightarrow \theta = ...$ Allow $\theta -$ their $59.04 = \cos^{-1}\left(\frac{2}{\text{their}\sqrt{34}}\right) \Rightarrow \theta = ...$ if they have $\theta +$ .. in (b) Evidence that use is being made of parts (a) and (b) to obtain a value for θ. This can be implied by the use of their answers to part (b).		M1
	$\theta = 10.9°$	awrt 10.9	A1
			(2)
			(9 marks)

8 (a)	$\sin 2x - \tan x \equiv 2\sin x\cos x - \dfrac{\sin x}{\cos x}$	Uses a **correct** identity for sin2x	M1
	$\equiv \dfrac{2\sin x\cos x\cos x}{\cos x} - \dfrac{\sin x}{\cos x}$	Obtains common denominator. This is **NOT** dependent upon the previous M so accept expressions like, $\sin 2x - \tan x \equiv \sin 2x - \dfrac{\sin x}{\cos x}$ $= \dfrac{\sin 2x\cos x - \sin x}{\cos x}$	M1
	$\equiv \dfrac{2\cos^2 x\sin x - \sin x}{\cos x}$	Correct fraction with just sin x and cos x	A1
	$\equiv \dfrac{(2\cos^2 x - 1)\sin x}{\cos x} \equiv \cos 2x\tan x^*$	Uses a correct identity for cos2x and completes correctly with no errors. An error could be for example, mixed variables used or loss of an x along the way.	A1*

	Alternative 1 for (a)		
	$\sin 2x - \tan x \equiv 2\sin x\cos x - \dfrac{\sin x}{\cos x}$	Uses a **correct** identity for sin2x	M1
	$\dfrac{\sin x}{\cos x}\left(2\cos^2 x - 1\right)$	M1: Takes out a factor of $\dfrac{\sin x}{\cos x}$	M1A1
		A1: Correct expression	
	$\equiv \tan x\cos 2x^*$	Completes correctly with no errors.	A1*

	Alternative 2 for (a)		
	$2\sin x\cos x - \dfrac{\sin x}{\cos x} \equiv \dfrac{\sin x}{\cos x}\left(\cos^2 x - \sin^2 x\right)$	Uses a **correct** identity for sin2x	M1
	$2\sin x\cos^2 x - \sin x \equiv \sin x\left(\cos^2 x - \sin^2 x\right)$	Multiplies **both sides** by cos x	M1
	$2\cos^2 x - 1 \equiv \left(\cos^2 x - \sin^2 x\right)$	Correct identity	A1
	This is true*	Conclusion provided	A1*

	Alternative 3 for (a)		
	$\tan x\cos 2x \equiv \dfrac{\sin x}{\cos x}\left(2\cos^2 x - 1\right)$	Uses a **correct** identity for cos2x	M1
	$\equiv 2\sin x\cos x - \dfrac{\sin x}{\cos x}$	M1: Multiplies out	M1A1
		A1: Correct expression	
	$\equiv \sin 2x - \tan x^*$	A1: Obtains lhs with no errors	A1*

8(b)(i)	$\sin 2\theta - \tan\theta = \sqrt{3}\cos 2\theta \Rightarrow \tan\theta\cos 2\theta = \sqrt{3}\cos 2\theta$		
	$\tan\theta = \sqrt{3} \Rightarrow \theta = \frac{\pi}{3} = (\text{awrt } 1.05)$	M1: $\tan\theta = \pm\sqrt{3} \Rightarrow \theta = ...$ A1: $\theta = \frac{\pi}{3}$ Accept awrt 1.05. Ignore solutions outside the range but withhold the A mark for extra solutions in range.	M1A1
	$\cos 2\theta = 0 \Rightarrow \theta = \frac{\pi}{4}$ (awrt 0.785)	M1: $\cos 2\theta = 0 \Rightarrow \theta = ...$ A1: $\theta = \frac{\pi}{4}$ Accept awrt 0.785. Ignore solutions outside the range but withhold the A mark for extra solutions in range.	M1A1
(b)(ii)	$\tan(\theta+1)\cos(2\theta+2) - \sin(2\theta+2) = 2 \Rightarrow \tan(\theta+1) = -2$ M1: $\tan(\theta+1) = \pm 2$		M1
	$\Rightarrow \theta = \arctan(-2) - 1$	Correct order of operations i.e. $\theta = \arctan(\pm 2) - 1$. This may be implied by $\theta = -2.1\ldots$	dM1
	$\Rightarrow \theta = 1.03$	awrt $\theta = 1.03$. Ignore solutions outside the range but withhold the A mark for extra solutions in range.	A1
			(7)
			(11 marks)

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8 (a)	$\tan(2x+x)=\dfrac{\tan 2x+\tan x}{1-\tan 2x\tan x}$	M1
	$=\dfrac{\dfrac{2\tan x}{1-\tan^2 x}+\tan x}{1-\dfrac{2\tan x}{1-\tan^2 x}\tan x}$	dM1
	$=\dfrac{2\tan x+\tan x(1-\tan^2 x)}{1-\tan^2 x-2\tan^2 x}$ OR $=\dfrac{\dfrac{2\tan x+\tan x-\tan^3 x}{1-\tan^2 x}}{\dfrac{1-\tan^2 x-2\tan^2 x}{1-\tan^2 x}}$ oe	A1
	So $\tan 3x=\dfrac{3\tan x-\tan^3 x}{1-3\tan^2 x}$ *	A1*cso
		(4)
(b)	Put $\dfrac{3\tan x-\tan^3 x}{1-3\tan^2 x}=11\tan x$ so $3\tan x-\tan^3 x=11\tan x(1-3\tan^2 x)$	M1
	$32\tan^3 x=8\tan x$	A1
	So $\tan x=\pm\dfrac{1}{2}$ or $0\Rightarrow x=..$	dM1
	$\Rightarrow x=$ awrt $26.6°$, $-26.6°$, 0	A1 A1
		(5)
		(9 marks)

11. (a)	$R=37$	B1
	$\tan\alpha=\dfrac{12}{35}\Rightarrow\alpha=$ awrt 0.3303	M1 A1
		(3)
(b)	$\sin(x-\alpha)=\dfrac{37}{2R}$ $(=0.5...)$	M1
	$x=\arcsin\left(\dfrac{37}{2\times\text{their "37"}}\right)+\text{their"0.3303"}$	M1
	$x=$awrt 0.854 or awrt 2.95	A1
	$x=$awrt 0.854 and awrt 2.95	A1
		(4)
(c)(i)	Find $y=\dfrac{7000}{31+(\pm\text{"}R\text{"})^2}=5$	M1 A1
(c)(ii)	$x-\alpha=\frac{\pi}{2}\Rightarrow x=1.90$	M1 A1
		(4)
		(11 marks)

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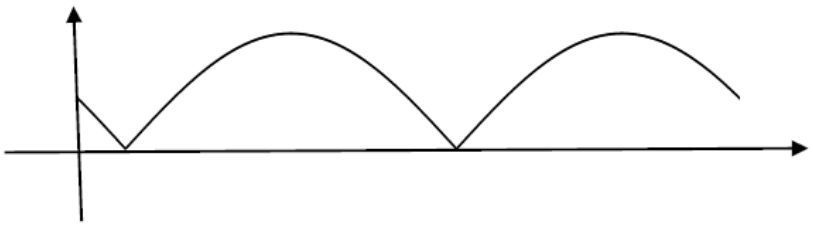
7(a)	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{1-\left(1-2\sin^2 x\right)}{1+\left(2\cos^2 x-1\right)}=\frac{2\sin^2 x}{2\cos^2 x}=\tan^2 x$	M1dM1A1
	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{1-\left(1-2\sin^2 x\right)}{1+\left(2\cos^2 x-1\right)}=\frac{\sin^2 x}{\cos^2 x}=\tan^2 x$	M1dM1A0
	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{1-\cos^2 x+\sin^2 x}{1+\cos^2 x-\sin^2 x}=\frac{2\sin^2 x}{2\cos^2 x}=\tan^2 x$	M1dM1A1
	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{1-\cos^2 x+\sin^2 x}{1+\cos^2 x-\sin^2 x}=\frac{\sin^2 x}{\cos^2 x}=\tan^2 x$	M1dM1A0
	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{2\sin^2 x}{2\cos^2 x}=\tan^2 x$	M1dM1A1
	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{\sin^2 x}{\cos^2 x}=\tan^2 x$	M0dM0A0
	$\frac{1-\cos 2x}{1+\cos 2x}=\frac{1-\cos^2 x+\sin^2 x}{1+\cos^2 x-\sin^2 x}$ $=\frac{\cos^2 x+\sin^2 x-\cos^2 x+\sin^2 x}{2\cos^2 x}=\frac{\sin^2 x}{\cos^2 x}=\tan^2 x$	M1dM1A0
		(3)

(b)	$\frac{2-2\cos 2\theta}{1+\cos 2\theta}-2=7\sec\theta$	
	$2\left(\frac{1-\cos 2\theta}{1+\cos 2\theta}\right)-2=7\sec\theta \Rightarrow 2\tan^2\theta-2=7\sec\theta$	M1
	$\Rightarrow 2\left(\sec^2\theta-1\right)-2=7\sec\theta$	M1
	$\Rightarrow 2\sec^2\theta-7\sec\theta-4=0$	A1
	$\Rightarrow (2\sec\theta+1)(\sec\theta-4)=0$	
	$\Rightarrow \sec\theta=-\frac{1}{2},4$	
	$\Rightarrow \cos\theta=-2,\frac{1}{4}\Rightarrow\theta=\ldots$	M1
	$\Rightarrow \theta=75.5°,-75.5°$	A1,A1
		(6)

7(a) alt1	$\tan^2 x=\frac{\sin^2 x}{\cos^2 x}=\frac{\frac{1}{2}(1-\cos 2x)}{\frac{1}{2}(1+\cos 2x)}=\frac{(1-\cos 2x)}{(1+\cos 2x)}$	M1dM1A1
7(a) alt2	$\frac{1-\cos 2x}{1+\cos 2x}=\tan^2 x \Rightarrow 1-\cos 2x=\tan^2 x(1+\cos 2x)$ $1-\left(1-2\sin^2 x\right)=\tan^2 x\left(1+2\cos^2 x-1\right)$ $2\sin^2 x=\frac{\sin^2 x}{\cos^2 x}\left(2\cos^2 x\right)$ $2\sin^2 x=2\sin^2 x$	M1dM1A1

7 (b)alt1	$2\left(\frac{1-\cos 2\theta}{1+\cos 2\theta}\right)-2=7\sec\theta \Rightarrow 2\tan^2\theta-2=7\sec\theta$	M1
	$\Rightarrow 2\frac{\sin^2\theta}{\cos^2\theta}-2=\frac{7}{\cos\theta}$ $\Rightarrow 2\sin^2\theta-2\cos^2\theta=7\cos\theta$ $\Rightarrow 2(1-\cos^2\theta)-2\cos^2\theta=7\cos\theta$	M1
	$\Rightarrow 4\cos^2\theta+7\cos\theta-2=0$	A1
	$\Rightarrow (4\cos\theta-1)(\cos\theta+2)=0$	
	$\Rightarrow \cos\theta=-2,\frac{1}{4} \Rightarrow \theta=\ldots$	M1
	$\Rightarrow \theta=75.5°,-75.5°$	A1A1
		(6)

7 (b)alt2	$2\left(\frac{1-\cos 2\theta}{1+\cos 2\theta}\right)-2=7\sec\theta \Rightarrow 2\tan^2\theta-2=7\sec\theta$	M1
	$2\tan^2\theta-2=7\sqrt{1+\tan^2\theta}$ $\left(2\tan^2\theta-2\right)^2=\left(7\sqrt{1+\tan^2\theta}\right)^2 \Rightarrow 4\tan^4\theta-8\tan^2\theta+4=49\left(1+\tan^2\theta\right)$	M1
	$4\tan^4\theta-57\tan^2\theta-45=0$	A1
	$\left(4\tan^2\theta+3\right)\left(\tan^2\theta-15\right)=0 \Rightarrow \tan^2\theta=15$	
	$\tan\theta=\sqrt{15} \Rightarrow \theta=\ldots$	M1
	$\Rightarrow \theta=75.5°,-75.5°$	A1A1
		(6)

10(a)	$R=\sqrt{5}$	B1
	$\tan\alpha=\frac{1}{2} \Rightarrow (\alpha=)26.6°$	M1,A1
		(3)
(b)	 Shape	B1
	$(0,1)$	B1
	$("26.6",0)$ and $("206.6",0)$ (Allow in radians i.e. their α and π+α	B1ft
		(3)
(c)(i)	$5+'R'=5+\sqrt{5}$	B1ft
(c)(ii)	$15t-'26.6'=270 \Rightarrow t=19.8$	M1,A1
		(3)
		(9 marks)

2017 Oct C34

4 (a)	$\frac{1-\cos 2x}{\sin 2x} \equiv \frac{1-\left(1-2\sin^2 x\right)}{2\sin x\cos x} = \frac{2\sin x\sin x}{2\sin x\cos x}$ Allow $\frac{1-\cos 2x}{\sin 2x} \equiv \frac{2\sin^2 x}{2\sin x\cos x}$	M1A1
	$= \frac{\sin x}{\cos x} = \tan x$	A1*
		(3)
	Examples	
	$\frac{1-\cos 2x}{\sin 2x} \equiv \frac{1-1+2\sin^2 x}{2\sin x\cos x} = \frac{\sin x}{\cos x} = \tan x$	M1A1A1
	$\frac{1-\cos 2x}{\sin 2x} \equiv \frac{1-\left(1-2\sin^2 x\right)}{2\sin x\cos x} = \frac{\sin x}{\cos x} = \tan x$	M1A1A1
	$\frac{1-\cos 2x}{\sin 2x} \equiv \frac{2\sin^2 x}{2\sin x\cos x} = \tan x$	M1A1A0
	$\frac{1-\cos 2x}{\sin 2x} \equiv \frac{\cancel{2}\sin^{\cancel{2}} x}{\cancel{2}\sin x\cos x} = \tan x$	M1A1A1
		(3)

(b)	$3\sec^2\theta - 7 = \frac{1-\cos 2\theta}{\sin 2\theta} \Rightarrow 3\sec^2\theta - 7 = \tan\theta$	M1
	$\Rightarrow 3\left(1+\tan^2\theta\right) - 7 = \tan\theta$	M1
	$\Rightarrow 3\tan^2\theta - \tan\theta - 4 = 0$	A1
	$\Rightarrow (3\tan\theta - 4)(\tan\theta + 1) = 0$	
	$\Rightarrow \tan\theta = \frac{4}{3}, \tan\theta = -1$	**d**M1
	$\theta = 0.927, 4.069, \frac{3}{4}\pi\left(2.356\right), \frac{7}{4}\pi\left(5.498\right)$	A1 A1
		(6)
		(9 marks)

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9 (a)	**Way 1 LHS → RHS:** $\dfrac{\cot^2 x}{1+\cot^2 x} \equiv \dfrac{\cos^2 x \,/\, \sin^2 x}{\operatorname{cosec}^2 x}, \equiv \dfrac{\cos^2 x \,/\, \sin^2 x}{1 \,/\, \sin^2 x} \equiv \cos^2 x$	M1 M1, A1*
	Way 2 LHS → RHS:: $\dfrac{\cot^2 x}{1+\cot^2 x} \times \dfrac{\sin^2 x}{\sin^2 x} \equiv \dfrac{\cos^2 x}{\sin^2 x+\cos^2 x}, \equiv \dfrac{\cos^2 x}{1}, \equiv \cos^2 x$	M1, M1, A1*
	Way 3 LHS → RHS: $\dfrac{\cot^2 x}{1+\cot^2 x} \equiv \dfrac{1 \,/\, \tan^2 x}{1+1 \,/\, \tan^2 x} \equiv \dfrac{1}{1+\tan^2 x} \equiv \dfrac{1}{\sec^2 x}, \equiv \cos^2 x$	M1, M1, A1*
	Way 4: LHS → RHS:: $\dfrac{\cot^2 x}{1+\cot^2 x} \equiv \dfrac{\operatorname{cosec}^2 x - 1}{\operatorname{cosec}^2 x} \equiv 1-\sin^2 x \equiv \cos^2 x$	M1 M1 A1*
	Way 5: Considers both sides $\cos^2 x(1+\cot^2 x) = \cos^2 x\left(1+\dfrac{\cos^2 x}{\sin^2 x}\right) = \dfrac{\cos^2 x(\sin^2 x+\cos^2 x)}{\sin^2 x} = \dfrac{\cos^2 x}{\sin^2 x} = \cot^2 x$	M1 M1
	Hence $\dfrac{\cot^2 x}{1+\cot^2 x} \equiv \cos^2 x$	A1*
		(3)
(b)	$\cos^2 x = 8(2\cos^2 x - 1) + 2\cos x$	M1
	$15\cos^2 x + 2\cos x - 8 = 0$	A1
	So $\cos x = 2/3$ or $-4/5$	M1
	$\Rightarrow x = 48.2°$ or $143.1°$ or $216.9°$ or $311.8°$	dM1, A1 A1
		(6)

12. (a)	$R = \sqrt{4+16} = \sqrt{20}$ *or* $2\sqrt{5}$	B1
	$\tan\alpha = \frac{4}{2}$	M1
	$\Rightarrow \alpha = 1.11$ (awrt)	A1
		(3)
(b)	Maximum is $12+2R$ or minimum is $12-2R$	M1
	maximum = 20.9 (hours) (20h 57m) and minimum = 3.06 (hours) (3 hours 3 m)	A1 A1
		(3)
(c)	$17 = 12 + k"R"\sin\left(\frac{2\pi t}{365} \pm "\alpha"\right)$	M1
	$\sin\left(\frac{2\pi t}{365} \pm "\alpha"\right) = ...$	dM1
	For proceeding to one value for t from $17 = 12 + 2"R"\sin\left(\frac{2\pi t}{365} \pm "\alpha"\right)$	M1
	$t = 99$ (days) **or** 212 or 213 (days)	A1
	For finding two values for t	dM1
	$t = 99$ (days) **and** 212 or 213 (days)	A1
		(6)
		(12 marks)

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6.	$\sqrt{5}\cos\theta - 2\sin\theta \,..\, R\cos(\theta+\alpha)$		
(a)	$R = 3$	$R = 3$, **cao** (±3 is B0) ($\sqrt{9}$ is B0)	B1
	$\tan\alpha = \pm\frac{2}{\sqrt{5}}$, $\tan\alpha = \pm\frac{\sqrt{5}}{2} \Rightarrow \alpha = ...$ (Also allow $\cos\alpha = \pm\frac{\sqrt{5}}{3}$ or $\pm\frac{2}{3}$, $\sin\alpha = \pm\frac{2}{3}$ or $\pm\frac{\sqrt{5}}{3} \Rightarrow \alpha = ...$, where "3" is their R.)		M1
	$\alpha = 0.7297276562... \Rightarrow \alpha = 0.7297$ (4 sf)	Anything that rounds to 0.7297 (Degrees is 41.81 and scores A0)	A1
	{**Note**: $\sqrt{5}\cos\theta - 2\sin\theta = 3\cos(\theta + 0.7297)$}		**[3]**
(b)	$\sqrt{5}\cos\theta - 2\sin\theta = 0.5$		
	$3\cos(\theta + 0.7297) = 0.5$ $\Rightarrow \cos(\theta + 0.7297) = \frac{0.5}{3}$	Attempts to use part (a) "3"$\cos(\theta \pm$"0.7297"$) = 0.5$ 9and proceeds to $\cos(\theta \pm$"0.7297"$) = K$, $\lvert K\rvert < 1$ May be implied by $\theta \pm$"0.7297"$= 1.4033$ or $\theta \pm$"0.7297"$= \cos^{-1}\left(\frac{0.5}{\text{their } 3}\right)(= 1.4033...)$	M1
	$\theta_1 = 0.673648... \Rightarrow \theta_1 = 0.674$ (3 sf)	Anything that rounds to 0.674	A1
	$\theta_2 +$"0.7297"$=$"-1.4033"$\Rightarrow \theta_2 = ...$	**dependent on the previous M mark** Correct attempt at a second solution in the range. Usually given for: $\theta_2 +$ their 0.7297 $=-$ their 1.4033 $\Rightarrow \theta_2 = ...$	dM1
	$\theta_2 = -2.133048... \Rightarrow \theta_2 = -2.13$ (3 sf)	Anything that rounds to – 2.13	A1
	For solutions in (b) that are otherwise fully correct, if there are extra answers in the range, deduct the final A mark.		
	For candidates who work consistently in degrees in (a) and (b) allow awrt 38.6° and awrt – 122° in part (b) as the A mark will be lost in part (a)		
			[4]

(c)	$f(x) = A\left(\sqrt{5}\cos\theta - 2\sin\theta\right) + B, \theta \in \mathbb{R}; -15 \leqslant f(x) \leqslant 33$ $\Rightarrow -15 \leqslant 3A\cos(\theta + 0.730) + B \leqslant 33$		
	Note that part (c) is now marked as B1M1A1A1		
	$B = 9$	Correct value for B	B1
	$\boxed{\begin{matrix}3A + B = 33\\ -3A + B = -15\end{matrix}}$ or $\boxed{\begin{matrix}3A + B = -15\\ -3A + B = 33\end{matrix}}$	Writes down at least one pair of simultaneous equations (or inequalities) of the form $\boxed{\begin{matrix}RA + B = 33\\ -RA + B = -15\end{matrix}}$ or $\boxed{\begin{matrix}RA + B = -15\\ -RA + B = 33\end{matrix}}$ and finds at least one value for A	M1
	$A = 8$ **or** $A = -8$	One correct value for A	A1
	$A = 8$ **and** $A = -8$	Both values correct	A1
			[4]
			11

12.	$\cot x - \tan x \equiv 2\cot 2x$		
(a)	$\cot x - \tan x = \frac{\cos x}{\sin x} - \frac{\sin x}{\cos x}$	Attempts to write both $\cot x$ and $\tan x$ in terms of $\sin x$ and $\cos x$ only	M1
	$= \frac{\cos^2 x}{\sin x \cos x} - \frac{\sin^2 x}{\cos x \sin x} \left(= \frac{\cos^2 x - \sin^2 x}{\sin x \cos x} \right)$	**Dependent on the previous M mark** Attempts to find the same denominator for both fractions	dM1
	$= \frac{\cos 2x}{\frac{1}{2}\sin 2x} \left(= \frac{2\cos 2x}{\sin 2x} \right)$	**Dependent on both the previous M marks.** Evidence of correctly applying either $\cos 2x = \cos^2 x - \sin^2 x$ or $\sin 2x = 2\sin x \cos x$	ddM1
	$= 2\cot 2x$ (*)	Correct proof with no notational or other errors such as missing x's or inconsistent variables.	A1 *
			[4]

(a) **Alt 1**	$\cot x - \tan x = \frac{1}{\tan x} - \tan x$	Writes $\cot x$ in terms of $\tan x$	M1
	$\frac{1}{\tan x} - \frac{\tan^2 x}{\tan x} \left(= \frac{1 - \tan^2 x}{\tan x} \right)$	**Dependent on the previous M mark** Attempts to find the same denominator for both fractions	dM1
	$\frac{2}{\tan 2x}$	**Dependent on both the previous M marks.** Evidence of correctly applying $\tan 2x = \frac{2\tan x}{1 - \tan^2 x}$	ddM1
	$= 2\cot 2x$ (*)	Correct proof with no notational or other errors such as missing x's or inconsistent variables.	A1*
			[4]
(a) **Alt 2**	$2\cot 2x = \frac{2}{\tan 2x}$	Applies $\cot 2x = \frac{1}{\tan 2x}$	M1
	$= \frac{2}{\frac{2\tan x}{1 - \tan^2 x}}$	**Dependent on the previous M mark** Attempts to apply the double angle formula for $\tan 2x$	dM1
	$= \frac{1 - \tan^2 x}{\tan x} = \frac{1}{\tan x} - \tan x$	**Dependent on both the previous M marks.** Obtains a rational fraction with a single denominator and attempts to split this up into 2 terms	ddM1
	$= \cot x - \tan x$ (*)	Correct proof with no notational or other errors such as missing x's or inconsistent variables.	A1 *
			[4]

(b)	$5+\cot(\theta-15°)-\tan(\theta-15°)=0$		
	$\Rightarrow 5+2\cot(...)=0$	Obtains an equation of this form.	M1
	$\cot(...)=-\frac{5}{2}\Rightarrow \tan(...)=-\frac{2}{5}$	Obtains an equation of the form $\tan(...)=\pm\frac{2}{5}$	M1
	$2\theta-30=\tan^{-1}\left(-\frac{2}{5}\right)$	Can be implied by e.g. $2\theta-30=$ awrt -21.8 or $2\theta-30=$ awrt 158.2	A1
	$\theta=$ awrt $4.1°$ **or** $\theta=$ awrt $94.1°$	One correct answer e.g. anything that rounds to 4.1 or anything that rounds to 94.1	A1
	$\theta=$ awrt $4.1°$ **and** $\theta=$ awrt $94.1°$	Both answers correct. Ignore any extra answers out of range but withhold this mark if there are any extra values in range.	A1
			[5]

	Alternative to part (b):		
	$5+\cot(...)-\tan(...)=0\Rightarrow 5\tan(...)+1-\tan^2(...)$ $\tan^2(...)-5\tan(...)-1=0$ Multiples through by $\tan(...)$ to obtain a 3TQ in $\tan(...)$		M1
	$\tan(...)=\frac{5\pm\sqrt{25+4}}{2}$	Solves their 3TQ and proceeds to tan(…) =	M1
	$(\theta-15°)=\tan^{-1}\left(\frac{5\pm\sqrt{25+4}}{2}\right)$	Can be implied by e.g. $\theta-15=79.099...$ or $\theta-15=-10.900...$	A1
	$\theta=$ awrt $4.1°$ **or** $\theta=$ awrt $94.1°$	One correct answer e.g. anything that rounds to 4.1 or anything that rounds to 94.1	A1
	$\theta=$ awrt $4.1°$ **and** $\theta=$ awrt $94.1°$	Both answers correct. Ignore any extra answers out of range but withhold this mark if there are any extra values in range.	A1
			[5]

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1(a)	$\cos\theta + 4\sin\theta = R\cos(\theta - \alpha)$	
	$R = \sqrt{1^2 + 4^2} = \sqrt{17}$	B1
	$\alpha = \arctan 4 = \text{awrt } 1.326$	M1A1
		(3)
(b)	$\sqrt{17}\cos(2\theta - 1.326) = 1.2 \Rightarrow \cos(2\theta - 1.326) = \dfrac{1.2}{\sqrt{17}}$	M1
	$\Rightarrow (2\theta - 1.326) = \pm 1.275.. \Rightarrow \theta = ...$	dM1
	$\theta = \text{awrt } 1.30 \text{ or awrt } 0.03$	A1
	$2\theta - 1.326 = \text{'}1.275...\text{'}..$ **and** $\text{'}-1.275...\text{'}$	ddM1
	$\Rightarrow \theta = \text{awrt } 1.30$ **and** 0.03	A1
		(5)
		[8 marks]

3.(a)	$\sec\theta^\circ = \dfrac{1}{\cos\theta^\circ} = \dfrac{1}{p}$ oe	B1
		(1)
(b)	$\sin(\theta - 90)^\circ = \sin\theta^\circ\cos 90^\circ - \cos\theta^\circ\sin 90^\circ = -p$	M1A1
		(2)
(c)	$\sin 2\theta^\circ = 2\sin\theta^\circ\cos\theta^\circ$	B1
	Uses $\sin\theta^\circ = \sqrt{1-\cos^2\theta^\circ} = \sqrt{1-p^2}, \Rightarrow \sin 2\theta^\circ = 2p\sqrt{1-p^2}$	M1, A1
		(3)
		[6 marks]

2019 Jan C34

1(a)	$R=\sqrt{53}$	cao	B1
	$\tan\alpha=\frac{2}{7}\Rightarrow\alpha=...$ $\tan\alpha=\pm\frac{2}{7}$ or $\tan\alpha=\pm\frac{7}{2}$ or $\sin\alpha=\pm\frac{2}{'\sqrt{53}'}$ or $\sin\alpha=\pm\frac{7}{'\sqrt{53}'}$ or $\cos\alpha=\pm\frac{7}{'\sqrt{53}'}$ or $\cos\alpha=\pm\frac{2}{'\sqrt{53}'}$ $\Rightarrow\alpha=...$ Uses one of these equations to find a value for α		M1
	$\alpha=15.95°$	Awrt $15.95°$ (Allow awrt 0.28 (rad))	A1
			(3)
(b)	$\sqrt{53}\sin(2\theta-15.95°)=4\Rightarrow\sin(2\theta-15.95°)=\frac{4}{\sqrt{53}}(0.549)$ Attempts to use part (a) $"\sqrt{53}"\sin(2\theta-"15.95°")=4$ and proceeds to $\sin(2\theta\pm"15.95°")=K,\quad\lvert K\rvert<1$ Allow the letter α for "15.95"		M1
	$2\theta-15.95°=33.3287...\Rightarrow\theta=24.6°$	Awrt $24.6°$ (Allow awrt 0.43 (rad))	A1
	$2\theta-15.95°=180°-33.287...\Rightarrow\theta=...$ Correct attempt at a second solution in the range. E.g. $2\theta_2\mp'15.95°'=180°-'33.3287...°'\Rightarrow\theta_2=\frac{180°-'33.3287...°'\pm'15.95°'}{2}$ (May be implied by their θ_2) It is **dependent** upon having scored the previous M. **Do not allow mixing of radians and degrees so if working in radians must be using π not 180**		dM1
	$\theta=81.3°$	Awrt $81.3°$ **only**	A1
	Ignore extra answers outside range but deduct the final A for extra answers in range.		
			(4)
(c)	$28\sin\theta\cos\theta=a\sin2\theta\Rightarrow a=14$	$a=14$	B1
	$8\sin^2\theta=b\left(\pm1\pm2\sin^2\theta\right)+c$ or $8\sin^2\theta=8\left(\frac{1}{2}\left(\pm1\pm\cos2\theta\right)\right)$ or $8\sin^2\theta=4\sin^2\theta+4\sin^2\theta=4\sin^2\theta+4\left(1-\cos^2\theta\right)=\pm4\cos2\theta\pm4$ Attempts to use a $\cos2\theta$ identity e.g. $\cos2\theta=\pm1\pm2\sin^2\theta$ or $\sin^2\theta=\frac{1}{2}\left(\pm1\pm\cos2\theta\right)$ at some point in their working and applies it to the given expression.		M1
	$b=-4,\ c=4$ or $...-4\cos2\theta+4$	Correct values or correct expression	A1
			(3)
(d)	$\left(28\sin\theta\cos\theta+8\sin^2\theta\right)_{max}=2'\sqrt{53}'+'4'$	Maximum $=2\times$ their$\sqrt{53}+$ their c May be implied e.g. by their decimal answer.	M1
	$2\sqrt{53}+4$	Cao (must be exact not decimals)	A1
	Attempts to use calculus for the maximum should reach $2R+c$ as above for M1 .		
			(2)
			Total 12

5	$\tan x = m$ and $4\tan y = 8m+5$		
(a)	Examples: $\sec^2 x = 1+m^2$ or $\sec^2 y = 1+\left(\frac{8m+5}{4}\right)^2$ or $16\sec^2 y = 16+16(8m+5)^2$	Attempts to express $\sec^2 x$ or $\sec^2 y$ in terms of m using a **correct** identity.	M1
	$16(\sec^2 x+\sec^2 y) = 16\left(1+m^2+1+\left(\frac{8m+5}{4}\right)^2\right) = 537$ Uses their expressions in m and 537 to obtain a quadratic equation in terms of m which may be unsimplified.		M1
	$m^2+m-6=0 \Rightarrow m = 2, -3$	Solves their 3TQ as far as m = ...	M1
		Correct values	A1
			(4)
(b)	$\tan x = 2 \Rightarrow \sin x = \frac{2}{\sqrt{1^2+2^2}} = ...$ Correct method for the value of $\sin x$. Must be from an appropriate identity or exact work but m does not need to be exact. So e.g. $\sin(\tan^{-1}2) = 0.8944..$ scores M0 Can be for using either of their values of m.		M1
	$= \frac{2}{\sqrt{5}}$	cao (oe) **and no other values**	A1
			(2)
(c)	$\tan y = \frac{21}{4} \Rightarrow \cot y = \frac{4}{21}$	Correct method to obtain a value for $\cot y$. So uses $4\tan y = 8m+5$ and their m to find a value for $\tan y$ and finds reciprocal. Can be for using either of their values of m.	M1
		cao (oe) **and no other values**	A1
			(2)
			Total 8

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7(a)	$5\cos\theta - 3\sin\theta = R\cos(\theta + \alpha)$		
	$R = \sqrt{5^2 + 3^2} = \sqrt{34}$	$R = \sqrt{34}$ $\left(R = \pm\sqrt{34} \text{ is B0}\right)$	B1
	$\tan\alpha = \pm\frac{3}{5}$, $\tan\alpha = \pm\frac{5}{3} \Rightarrow \alpha = ...$ (Also allow $\cos\alpha = \pm\frac{5}{\sqrt{34}}$ or $\pm\frac{3}{\sqrt{34}}$, $\sin\alpha = \pm\frac{3}{\sqrt{34}}$ or $\pm\frac{5}{\sqrt{34}} \Rightarrow \alpha = ...$, where "$\sqrt{34}$" is their R.)		M1
	$\alpha = \arctan\left(\frac{3}{5}\right) = $ awrt 0.5404	Anything that rounds to 0.5404 (Degrees is 30.96… and scores A0)	A1
			(3)

7(b)	$6 + 2.5\cos\left(\frac{4\pi t}{25}\right) - 1.5\sin\left(\frac{4\pi t}{25}\right) = 4.6 \Rightarrow \frac{\sqrt{34}}{2}\cos\left(\frac{4\pi t}{25} + 0.5404\right) = 4.6 - 6$ $\Rightarrow \cos\left(\frac{4\pi t}{25} + \text{"0.5404"}\right) = ...$ Uses part (a) and proceeds as far as $\cos\left(\frac{4\pi t}{25} \pm \text{their } 0.5404\right) = k$ or $\cos\ \theta \pm \text{their } 0.5404\ = k$ or $\cos\ t \pm \text{their } 0.5404\ = k$ where $\lvert k\rvert < 1$.		M1
	$\cos\left(\frac{4\pi t}{25} + \text{"0.5404"}\right) = -0.48$	Allow: $\cos\left(\frac{4\pi t}{25} \pm \text{their } 0.5404\right) = \text{awrt } -0.48$ **or** $\cos\ \theta \pm \text{their } 0.5404\ = \text{awrt } -0.48$ **or** $\cos\ t \pm \text{their } 0.5404\ = \text{awrt } -0.48$ May see $-\frac{7\sqrt{34}}{85}$ or $-\frac{2.8}{\sqrt{34}}$ for -0.48	A1

	$\frac{4\pi t}{25} + "0.5404" = 2.07 \Rightarrow t = ...$ **or** $\frac{4\pi t}{25} + "0.5404" = 2\pi - 2.07 \ = 4.21 \ \Rightarrow t = ...$ NB 2.07… may be seen as π – 1.07 and 4.21… may be seen as π + 1.07 $\cos\left(\frac{4\pi t}{25} \pm \text{their } 0.5404\right) = k \Rightarrow t = ..$ by first taking invcos then adds or subtracts their 0.5404 and applies $\frac{4\pi t}{25}$ to obtain a value for *t*. **Dependent on the previous method mark and may be implied by obtaining a value for *t* of awrt 3 or awrt 7.**		**d**M1
	awrt 3.05 or awrt 7.3	Allow awrt 3.05 **or** awrt 7.3	A1
	$\frac{4\pi t}{25} \pm "0.5404" = 2\pi - 2.07 \Rightarrow t = ...$ **and** $\frac{4\pi t}{25} \pm "0.5404" = 2.07 \Rightarrow t = ...$ For a correct method to find a different value of *t* in the range **Dependent on both previous method marks.**		**dd**M1
	3:03 or 15:03 or 3hrs 3min or 183minutes **and** 7:18 or 19:18 or 7hrs18min or 438minutes		A1
			(6)
			[9 marks]

9(a)	$\sin(2x+x) = \sin 2x \cos x + \cos 2x \sin x$ Attempts to use the identity for $\sin(A+B)$ with $A = 2x, B = x$ or vice versa Accept $\sin(2x+x) = \sin 2x \cos x \pm \cos 2x \sin x$ or $\sin(x+2x) = \sin x \cos 2x \pm \cos x \sin 2x$		M1
	$= 2\sin x \cos x \cos x + \left(1 - 2\sin^2 x\right)\sin x$	Uses the correct double angle identities for $\sin 2x$ and $\cos 2x$. Allow $\sin 2x = \sin x \cos x + \cos x \sin x$ If $\cos 2x = \cos^2 x - \sin^2 x$ is used, then the "$\cos^2 x$" term must be changed to $1 - \sin^2 x$ later in the solution. **Dependent on the first method mark.**	**d**M1
	$= 2\sin x\left(1 - \sin^2 x\right) + \left(1 - 2\sin^2 x\right)\sin x$	Reaches an expression in terms of $\sin x$ only by use of $\cos^2 x = 1 - \sin^2 x$	M1
	$= 3\sin x - 4\sin^3 x$	cso $\sin 3x \equiv 3\sin x - 4\sin^3 x$ or $\sin 3x \equiv 3\sin x + -4\sin^3 x$	A1
	Note: As this is not a "traditional" identity proof with the answer fully given, do not be overly concerned with minor notational errors such as e.g. cosx^2 rather than cos^2x or the odd missing "x". **Generally if all the method marks are scored with no clear errors and $3\sin x - 4\sin^3 x$ is reached, award full marks.**		
			(4)

2020 Jan P3

5 (a)	$12\tan 2x + 5\cot x \sec^2 x = 0$ $12\times\frac{2t}{1-t^2} + 5\times\frac{1}{t}\left(1+t^2\right) = 0$ $12\times 2t^2 + 5\left(1+t^2\right)\left(1-t^2\right) = 0 \rightarrow 5t^4 - 24t^2 - 5 = 0$ *	B1 M1 A1 A1* **(4)**
(b)	$5t^4 - 24t^2 - 5 = 0$ $\left(5t^2+1\right)\left(t^2-5\right) = 0$ Correct order of operations $t = (\pm)\sqrt{5} \Rightarrow x = ..$ Two of awrt $x = 66°, 114°, 246°, 294°$ All four of awrt $x = 65.9°, 114.1°, 245.9°, 294.1°$	M1 dM1 A1 A1 **(4)** **8 marks**

9.(a)	$R = \sqrt{41}$ $\tan\alpha = \frac{4}{5} \Rightarrow \alpha =$ awrt 0.675	B1 M1A1 (3)
(b)	(i) Describes stretch: stretch in the y direction by "$\sqrt{41}$" (ii) Describes translation: E.g. translate by $\begin{pmatrix} -\arctan\frac{4}{5} \\ 0 \end{pmatrix}$	B1 ft B1 ft (2)
(c)	Attempts either $g(\theta) = \frac{90}{4+\left(\sqrt{41}\right)^2}$ OR $g(\theta) = \frac{90}{4}$ Range $2 \leqslant g(\theta) \leqslant 22.5$	M1 A1 (2) **7 marks**

2020 Oct P3

1	$2\left(2\cos^2 x-1\right)=7\cos x$ $4\cos^2 x-7\cos x-2=0\Rightarrow \cos x=-\frac{1}{4}$ $\Rightarrow x=\arccos\left(-\frac{1}{4}\right)=104.5°,\ 255.5°$	M1 M1 A1 dM1 A1 **(5)** **(5 marks)**

5 (a)	$\sin 3x\equiv\sin(2x+x)\equiv\sin 2x\cos x+\cos 2x\sin x$ $\equiv 2\sin x\cos x\cos x+\left(1-2\sin^2 x\right)\sin x$ $\equiv 2\sin x\left(1-\sin^2 x\right)+\left(1-2\sin^2 x\right)\sin x$ $\equiv 3\sin x-4\sin^3 x$ *	M1 M1 ddM1 A1* **(4)**

7.(a)	$R=\sqrt{17}$ $\tan\alpha=4\Rightarrow\alpha=$ awrt 1.326	B1 M1A1 **(3)**
(b)	Minimum height $=\frac{24}{3+"R"}=3.37$ (metres)	M1 A1 **(2)**
(c)	Uses part (a) $10=\frac{24}{3+\sqrt{17}\cos\left(\frac{1}{2}t-1.326\right)}\Rightarrow\cos\left(\frac{1}{2}t-1.326\right)=\frac{-0.6}{\sqrt{17}}$ $t=$ awrt 6.09	M1 A1 M1 A1 **(4)** **(9 marks)**

2021 Jan P3

7(a)	Uses $\sin 2x = 2\sin x\cos x$ **AND** $\cos 2x = 1-2\sin^2 x$ o.e. in $\dfrac{\sin 2x}{\cos x}+\dfrac{\cos 2x}{\sin x}$	M1
	$\dfrac{\sin 2x}{\cos x}+\dfrac{\cos 2x}{\sin x}=\dfrac{2\sin x\cos x}{\cos x}+\dfrac{1-2\sin^2 x}{\sin x}$ $=\dfrac{2\sin x\cancel{\cos x}}{\cancel{\cos x}}+\dfrac{1}{\sin x}-\dfrac{2\sin\cancel{^2} x}{\cancel{\sin x}} = \dfrac{1}{\sin x} = \text{cosec } x^*$	dM1 A1*
		(3)
(b)	Uses part (a) $\Rightarrow 7+\text{cosec } 2\theta = 3\cot^2 2\theta$	B1
	Either Uses $\pm 1 \pm \cot^2 2\theta = \pm\text{cosec}^2 2\theta \rightarrow$ 3TQ in cosec 2θ **Or alternatively** replaces cosec2θ with $1/\sin 2\theta$, $\cot^2 2\theta$ with $\cos^2 2\theta/\sin^2 2\theta$, multiplies by $\sin^2 2\theta$ and uses $\pm\cos^2 2\theta = \pm 1 \pm \sin^2 2\theta \rightarrow$ 3TQ in sin 2θ	M1
	$3\text{cosec}^2 2\theta - \text{cosec } 2\theta - 10 = 0$ **or** $10\sin^2 2\theta + \sin 2\theta - 3 = 0$	A1
	$(3\text{cosec } 2\theta + 5)(\text{cosec } 2\theta - 2) = 0$ **or** $(5\sin 2\theta + 3)(2\sin 2\theta - 1) = 0$ $\Rightarrow \text{cosec } 2\theta = -\dfrac{5}{3}, 2$ **or** $\Rightarrow \sin 2\theta = -\dfrac{3}{5}, \dfrac{1}{2}$ $\Rightarrow \sin 2\theta = -\dfrac{3}{5}, \dfrac{1}{2} \Rightarrow \theta = \ldots$	dM1
	$\theta = \dfrac{\pi}{12}(0.262),\ \dfrac{5\pi}{12}(1.31),\ -0.322,\ -1.25$ (awrt these values)	A1, A1
		(6)

2021 June P3

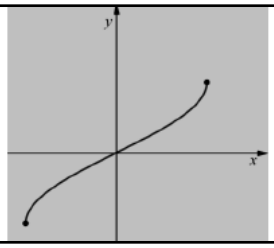
2(a)	States or uses $\sin 2x = 2\sin x\cos x$	B1
	$\dfrac{1-\cos 2x}{2\sin 2x} = \dfrac{1-\left(1-2\sin^2 x\right)}{4\sin x\cos x} = \dfrac{2\sin^2 x}{4\sin x\cos x} = \dfrac{1}{2}\tan x$	M1 A1
		(3)
(b)	$\dfrac{9(1-\cos 2\theta)}{2\sin 2\theta} = 2\sec^2\theta \Rightarrow 9\times"\dfrac{1}{2}"\tan\theta = 2\sec^2\theta$	M1
	Attempts $1+\tan^2\theta = \sec^2\theta \Rightarrow 4\tan^2\theta - 9\tan\theta + 4 = 0$	**d**M1 A1
	$\Rightarrow \tan\theta = \dfrac{9\pm\sqrt{17}}{8}(1.64038..., 0.60961...)$	M1
	$\Rightarrow \theta =$ awrt $31.4°, 58.6°$	A1 A1
		(6)

(b) Way 2	$\dfrac{9(1-\cos 2\theta)}{2\sin 2\theta} = 2\sec^2\theta \Rightarrow 9\times"\dfrac{1}{2}"\tan\theta = 2\sec^2\theta$	M1
	$\dfrac{9}{2}\tan\theta = 2\sec^2\theta \Rightarrow \dfrac{9\sin\theta}{\cos\theta} = \dfrac{4}{\cos^2\theta} \Rightarrow 9\sin\theta\cos\theta = 4 \Rightarrow \sin 2\theta = \dfrac{8}{9}$	**d**M1A1
	$\sin 2\theta = \dfrac{8}{9} \Rightarrow 2\theta = 62.7333..., 117.266... \Rightarrow \theta = ...$	M1
	$\Rightarrow \theta =$ awrt $31.4°, 58.6°$	A1 A1

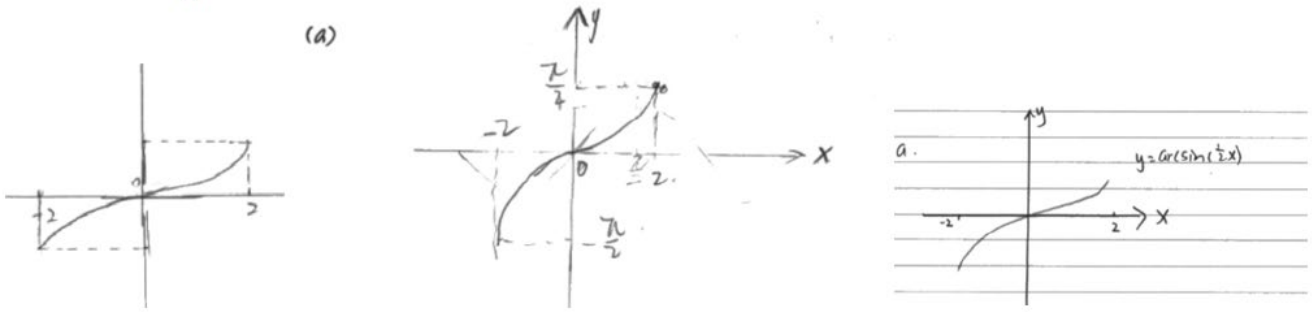
9(a)	$R = 13$	B1
	$\tan\alpha = \dfrac{5}{12} \Rightarrow \alpha =$ awrt 0.395	M1A1
		(3)
(b)	$g(\theta) = 10 + 13\sin\left(2\theta - \dfrac{\pi}{6} - 0.395\right)$	
(i)	(i) Minimum value is -3	B1 ft
(ii)	$2\theta - \dfrac{\pi}{6} - 0.395 = \dfrac{3\pi}{2} \Rightarrow \theta =$ awrt 2.82	M1 A1
		(3)
(c)	$h(\beta) = 10 - 169\sin^2(\beta - 0.395)$	
	$-159 \leqslant h \leqslant 10$	M1 A1
		(2)
		(8 marks)

2021 Oct P3

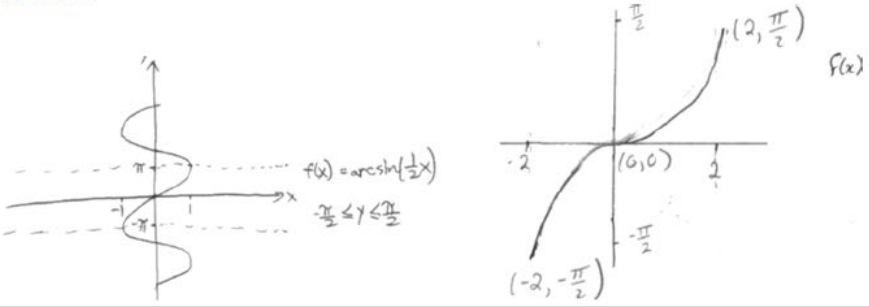
4 (a)	$2\sin(\theta-30°)=5\cos\theta \Rightarrow 2\sin\theta\cos 30°-2\cos\theta\sin 30°=5\cos\theta$ $\div\cos\theta \qquad \Rightarrow 2\tan\theta\cos 30°-2\sin 30°=5$ $\Rightarrow 2\tan\theta\times\frac{\sqrt{3}}{2}-2\times\frac{1}{2}=5$ $\Rightarrow \sqrt{3}\tan\theta=6 \Rightarrow \tan\theta=2\sqrt{3}$ *	M1 dM1 A1 A1*
		(4)
(b)	Attempts $\arctan 2\sqrt{3}$ ..and then subtracts $20°$ $\Rightarrow x=$ awrt $53.9°, 233.9°$	M1 A1, A1
		(3)
		(7 marks)

8 (a)	 Shape and position	B1 **(1)**

Examples of B1



Examples of B0



10.(a)	$(1+2\cos 2x)^2=1+4\cos 2x+4\cos^2 2x$ Uses $\cos 4x=2\cos^2 2x-1 \Rightarrow (1+2\cos 2x)^2=1+4\cos 2x+2\cos 4x+2$ $=3+4\cos 2x+2\cos 4x$	 M1 A1
		(2)

2022 Jan P3

2 (a)	$8\cos\theta = 3\operatorname{cosec}\theta$	
	States or uses $\operatorname{cosec}\theta = \dfrac{1}{\sin\theta}$	B1
	Attempts to use $\sin 2\theta = 2\sin\theta\cos\theta$	M1
	$\sin 2\theta = \dfrac{3}{4}$ cso	A1
		(3)
(b)	Correct order of operations to find θ, Look for $\dfrac{\arcsin\left(\frac{3}{4}\right)}{2}$	M1
	$(\theta =)$ awrt $24.3°$	A1
		(2)
		(5 marks)

9 (i)	$2\sec^2 x - 3\tan x = 2$	
	$2\left(1+\tan^2 x\right) - 3\tan x = 2$	M1
	$2\tan^2 x = 3\tan x \Rightarrow \tan x = \dfrac{3}{2}, (\tan x = 0)$	dM1
	$x =$ awrt $0.983, \pi$	A1, B1
		(4)
(ii)	$\dfrac{\sin 3\theta}{\sin\theta} - \dfrac{\cos 3\theta}{\cos\theta} \equiv \dfrac{\sin 3\theta\cos\theta - \cos 3\theta\sin\theta}{\sin\theta\cos\theta} \equiv \dfrac{\sin(3\theta-\theta)}{\sin\theta\cos\theta}$	M1
	$\equiv \dfrac{\sin(3\theta-\theta)}{\frac{1}{2}\sin 2\theta}$	dM1, A1
	$\equiv \dfrac{\cancel{\sin 2\theta}}{\frac{1}{2}\cancel{\sin 2\theta}} \equiv 2$ *	A1*
		(4)
		(8 marks)

2022 June P3

7(a)	$3\cot^2 2\theta - 7 = \dfrac{13}{2\sin\theta\cos\theta}$ **or** $2\sin\theta\left(3(\operatorname{cosec}^2 2\theta - 1) - 7\right) = 13\sec\theta$ **oe**	M1
	$3(\operatorname{cosec}^2 2\theta - 1) - 7 = \dfrac{13}{2\sin\theta\cos\theta}$	dM1
	$\Rightarrow 3\operatorname{cosec}^2 2\theta - 10 = 13\operatorname{cosec} 2\theta \Rightarrow 3\operatorname{cosec}^2 2\theta - 13\operatorname{cosec} 2\theta - 10 = 0$*	ddM1A1*
		(4)
(b)	$3\operatorname{cosec}^2 2\theta - 13\operatorname{cosec} 2\theta - 10 = 0$	
	$(3\operatorname{cosec} 2\theta + 2)(\operatorname{cosec} 2\theta - 5) = 0 \Rightarrow (\operatorname{cosec} 2\theta) = 5 \Rightarrow (\sin 2\theta) = \dfrac{1}{5}$	M1A1
	$\theta = \dfrac{\sin^{-1}\left("\frac{1}{5}"\right)}{2} = \ldots$	dM1
	$(\theta =)$ awrt 0.101, 1.47	A1
		(4)

Alt(a)	$2\sin\theta\left(\dfrac{3(1-\sin^2 2\theta)}{\sin^2 2\theta} - 7\right) = 13\sec\theta$	M1
	$\dfrac{3(1-\sin^2 2\theta)}{\sin^2 2\theta} - 7 = \dfrac{13}{2\sin\theta\cos\theta}$	dM1
	$\dfrac{3}{\sin^2 2\theta} - 10 = \dfrac{13}{\sin 2\theta}$	ddM1
	$3\operatorname{cosec}^2 2\theta - 13\operatorname{cosec} 2\theta - 10 = 0$ *	A1*

9(a)	$\dfrac{dy}{dx} = \dfrac{(1+\sin x)(-2\sin x) - (1+2\cos x)\cos x}{(1+\sin x)^2}$	M1A1
	$(1+\sin x)(-2\sin x) - (1+2\cos x)\cos x = 0$ $\Rightarrow -2\sin x - \cos x - 2 = 0$	dM1
	$2\sin x + \cos x = -2$ *	A1*
		(4)

(b)		
	Possible solutions from $R\sin(x+\alpha)$ or $R\cos(x-\alpha)$: $2\sin x+\cos x=-2 \Rightarrow \sqrt{5}\sin(x+0.464)=-2$ or $\sqrt{5}\cos(x-1.107)=-2$ or eg solutions from squaring $(2\sin x+\cos x)^2=4 \Rightarrow \cos x(3\cos x-4\sin x)=0$ --- $\sqrt{5}\sin(x+0.464)=-2$ or $\sqrt{5}\cos(x-1.107)=-2 \Rightarrow x=\ldots$ or $\tan x=\frac{3}{4} \Rightarrow x=\ldots$ $x=$ awrt 3.79	M1M1A1 dM1 A1
		(5)
		(9 marks)

2022 Oct P3

6	$\frac{d}{dx}(\cos x+\sin x)=-\sin x+\cos x$	**B1**
	$\frac{dy}{dx}=\frac{(\cos x+\sin x)(3\cos x)-(-\sin x+\cos x)(2+3\sin x)}{(\cos x+\sin x)^2}$	**M1** **A1**
	$=\frac{3\cos^2 x+\cancel{3\sin x\cos x}+2\sin x+3\sin^2 x-2\cos x-\cancel{3\sin x\cos x}}{\cos^2 x+2\sin x\cos x+\sin^2 x}$ $=\frac{3+2\sin x-2\cos x}{1+2\sin x\cos x}$	**M1**
	$=\frac{3+2\sin x-2\cos x}{1+2\sin x\cos x}\times\frac{\sec x}{\sec x}=\frac{3\sec x+2\sec x\sin x-2}{\sec x+2\sin x}$	**M1**
	$=\frac{2\tan x+3\sec x-2}{\sec x+2\sin x}$	**A1**
		(6)

8(a)	$R=17$	**B1**
	$\tan\alpha=\frac{15}{8}$	**M1**
	$\alpha=1.081$	**A1**
		(3)
(b)	(i) Min f(x) $=\frac{15}{41+2\times"17"}$	**M1**
	$=\frac{1}{5}$	**A1**
	(ii) Occurs when $\sin(x-1.081)=1\Rightarrow x-1.081=\frac{\pi}{2}\Rightarrow x=...$	**M1**
	$x=$ awrt 2.65	**A1**
		(4)
(c)	$-\frac{23}{5}$ (or -4.6)	**B1ft**
		(1)
(d)	Awrt 1.33	**B1ft**
		(1)
		(9 marks)

2023 Jan P3

2(a)	$R=\sqrt{5}$	B1
	$\tan\alpha=\frac{2}{1}\Rightarrow\alpha=...$	M1
	$\alpha=1.107$	A1
		(3)
(b)(i)	$\text{Max}=3+7\sqrt{5}$	B1ft
(b)(ii)	$(2x-"1.107")=\pi\Rightarrow x=...$	M1
	$\Rightarrow x=\frac{\pi+"1.107"}{2}=2.12$	A1
		(3)
		Total 6

5(a) Way One	$\cot^2 x-\tan^2 x\equiv\frac{\cos^2 x}{\sin^2 x}-\frac{\sin^2 x}{\cos^2 x}\equiv\frac{\cos^4 x-\sin^4 x}{\sin^2 x\cos^2 x}$	M1
	$\equiv\frac{(\cos^2 x-\sin^2 x)(\cos^2 x+\sin^2 x)}{\sin^2 x\cos^2 x}\equiv\frac{\cos 2x}{...}$ or $\frac{...}{\left(\frac{1}{2}\sin 2x\right)^2}$	dM1
	$\equiv\frac{\cos 2x}{\left(\frac{1}{2}\sin 2x\right)^2}$	A1
	$\equiv 4\frac{\cos 2x}{\sin 2x\sin 2x}\equiv 4\cot 2x\,\text{cosec}2x$ *	A1*
		(4)

(b)	$4\cot 2\theta\,\text{cosec}2\theta=2\tan^2\theta\Rightarrow\cot^2\theta-\tan^2\theta=2\tan^2\theta\Rightarrow\cot^2\theta-3\tan^2\theta=0$	M1
	$\cot^2\theta-3\tan^2\theta=0\Rightarrow\frac{1}{\tan^2\theta}-3\tan^2\theta=0\Rightarrow\tan^4\theta=\frac{1}{3}$	A1
	$\tan^4\theta="\frac{1}{3}"\Rightarrow\tan\theta=\pm\sqrt[4]{"\frac{1}{3}"}="\pm 0.7598.."\Rightarrow\theta=...$	M1
	$\theta=\text{awrt } 0.65,\ -0.65$	A1A1
		(5)
		Total 9

2023 June P3

5 (i)	States $x = 2$	B1
	$\sqrt{3}\sec x + 2 = 0 \Rightarrow \cos x = -\frac{\sqrt{3}}{2} \Rightarrow x = ...$	M1
	$x = \frac{5\pi}{6}$	A1
		(3)
(ii)	Attempts to use $\cos 2\theta = 1 - 2\sin^2\theta$	M1
	$6\sin^2\theta + 10\sin\theta - 3 = 0$	A1
	$\sin\theta = \frac{-5 \pm \sqrt{43}}{6} (= -1.926..., 0.2595...) \Rightarrow \theta = \arcsin(...)$	M1
	$\theta = 15.0°, 165°$	A1
		(4)
		(7 marks)

9(a)	$\frac{\cos 2x}{\sin x} + \frac{\sin 2x}{\cos x} = \frac{\cos 2x}{\sin x} + \frac{2\sin x \cos x}{\cos x}$ (One Correct identity)	B1
	$= \frac{1 - 2\sin^2 x}{\sin x} + \frac{2\sin x \cancel{\cos x}}{\cancel{\cos x}}$	M1
	$= \frac{1}{\sin x} - \frac{2\sin \cancel{x}}{\cancel{\sin x}} + 2\sin x = \frac{1}{\sin x} = \text{cosec } x$ *	A1*
		(3)
(b)	E.g. Equation is $\text{cosec}^2\theta = 6\cot\theta - 4 \Rightarrow 1 + \cot^2\theta = 6\cot\theta - 4$	M1
	E.g. $\cot^2\theta - 6\cot\theta + 5 = 0$	A1
	E.g. $\tan\theta = \frac{1}{5}, 1$	dM1
	$\theta = 0.197, \frac{\pi}{4}$	A1, A1
		(5)

2023 Oct P3

3(a)	$(\cos 2A \equiv)\cos A\cos A - \sin A\sin A \equiv \cos^2 A - (1-\cos^2 A)$	M1
	$\Rightarrow \cos 2A \equiv 2\cos^2 A - 1$ *	A1*
		(2)
(b)	$\int (3-2\cos 6x)\,dx = 3x - \frac{\sin 6x}{3}$ $(+c)$	M1A1
	$\left[3x - \frac{\sin 6x}{3}\right]_{\frac{\pi}{12}}^{\frac{\pi}{8}} = \left(3\left(\frac{\pi}{8}\right) - \frac{\sin\left(6\times\frac{\pi}{8}\right)}{3}\right) - \left(3\left(\frac{\pi}{12}\right) - \frac{\sin\left(6\times\frac{\pi}{12}\right)}{3}\right) = \frac{1}{8}\pi + \frac{2-\sqrt{2}}{6}$	dM1A1
		(4)

8(a)	Starting with the LHS: $2\text{cosec}^2 2\theta(1-\cos 2\theta) = \frac{2-2\cos 2\theta}{\sin^2 2\theta}$	M1
	$= \frac{2-2(1-2\sin^2\theta)}{4\sin^2\theta\cos^2\theta}$	M1dM1
	$= \sec^2\theta = 1+\tan^2\theta \equiv$ RHS *	A1*
		(4)
(b)	$\sec^2 x - 3\sec x - 4 = 0 \Rightarrow \sec x = ...$	M1
	$\cos x = \frac{1}{4}$ (ignore -1)	A1
	$\cos x = \frac{1}{4} \Rightarrow x = ...$	dM1
	$x = 75.5°,\ 284.5°$	A1
		(4)
		(8 marks)

2024 Jan P3

9(a)	$\dfrac{3\sin\theta\cos\theta}{\cos\theta+\sin\theta}=(2+\sec 2\theta)(\cos\theta-\sin\theta)$ $\Rightarrow\dfrac{3}{2}\sin 2\theta=(2+\sec 2\theta)(\cos\theta-\sin\theta)(\cos\theta+\sin\theta)$ **or** $\Rightarrow 3\sin\theta\cos\theta=(2+\sec 2\theta)\cos 2\theta$	M1
	$\Rightarrow\dfrac{3}{2}\sin 2\theta=(2+\sec 2\theta)\cos 2\theta$	**d**M1
	$\Rightarrow\dfrac{3}{2}\sin 2\theta=(2+\sec 2\theta)\cos 2\theta$ $\Rightarrow\dfrac{3}{2}\sin 2\theta=2\cos 2\theta+1\Rightarrow 3\sin 2\theta-4\cos 2\theta=2$ *	A1*
		(3)

(b)	Way 1 using $R\sin(2x-\alpha)$ or $R\cos(2x+\alpha)$	
	$\Rightarrow R=\sqrt{3^2+4^2}=\ldots(5)$ **or** $(\alpha=)\ \tan^{-1}\left(\frac{4}{3}\text{ or }\frac{3}{4}\right)=\ldots$	M1
	$\Rightarrow R=\sqrt{3^2+4^2}=\ldots(5)$ **and** $(\alpha=)\ \tan^{-1}\left(\frac{4}{3}\text{ or }\frac{3}{4}\right)=\ldots$	**d**M1
	$3\sin 2x-4\cos 2x=2\Rightarrow 5\sin(2x-0.927)=2$ **or** $3\sin 2x-4\cos 2x=2\Rightarrow 5\cos(2x+0.644)=-2$	A1
	$5\sin(2x-0.927)=2\Rightarrow x=\dfrac{\sin^{-1}\frac{2}{5}+0.927}{2}$ **or** $5\cos(2x+0.644)=-2\Rightarrow x=\dfrac{\cos^{-1}\frac{-2}{5}-0.644}{2}$	**dd**M1
	$x=$ awrt 3.81	A1
		(5)
		(8 marks)

(b)	Way 2 Squaring	
	$3\sin 2x-4\cos 2x=2 \Rightarrow 3\sin 2x=2+4\cos 2x$ $\Rightarrow 9\sin^2 2x=4+16\cos 2x+16\cos^2 2x$ or $3\sin 2x-4\cos 2x=2 \Rightarrow 3\sin 2x-2=4\cos 2x$ $\Rightarrow 9\sin^2 2x-12\sin 2x+4=16\cos^2 2x$	M1
	$9\left(1-\cos^2 2x\right)=4+16\cos 2x+16\cos^2 2x$ $\Rightarrow 25\cos^2 2x+16\cos 2x-5=0$ or $9\sin^2 2x-12\sin 2x+4=16\left(1-\sin^2 2x\right)$ $\Rightarrow 25\sin^2 2x-12\sin 2x-12=0$	**d**M1A1
	$25\cos^2 2x+16\cos 2x-5=0 \Rightarrow \cos 2x=\frac{-8\pm 3\sqrt{21}}{25}\left(0.23,\ -0.87\right)$ or $25\sin^2 2x-12\sin 2x-12=0 \Rightarrow \sin 2x=\frac{6\pm 4\sqrt{21}}{25}\left(0.97,\ -0.49\right)$ $\Rightarrow x=\ldots$	**dd**M1
	$x=$ awrt 3.81	A1

(b)	Way 3 Using double angle formulae	
	$3\sin 2x-4\cos 2x=2 \Rightarrow 6\sin x\cos x-4\cos^2 x+4\sin^2 x=2$	M1
	$6\sin x\cos x-4\cos^2 x+4\sin^2 x=2 \Rightarrow 6\tan x-4+4\tan^2 x=2\sec^2 x$ $\Rightarrow 6\tan x-4+4\tan^2 x=2\left(1+\tan^2 x\right)$ $\Rightarrow \tan^2 x+3\tan x-3=0$	**d**M1A1
	$\Rightarrow \tan^2 x+3\tan x-3=0 \Rightarrow \tan x=\frac{-3\pm\sqrt{21}}{2}\left(0.79,\ -3.79\right)$ $\Rightarrow x=\ldots$	**dd**M1
	$x=$ awrt 3.81	A1

(b)	Way 4 Divides by cos2x and squares	
	$3\sin 2x-4\cos 2x=2 \Rightarrow 3\tan 2x-4=2\sec 2x$ $\Rightarrow 9\tan^2 2x-24\tan 2x+16=4\sec^2 2x$	M1
	$\Rightarrow 9\tan^2 2x-24\tan 2x+16=4\left(1+\tan^2 2x\right)$ $\Rightarrow 5\tan^2 2x-24\tan 2x+12=0$	**d**M1A1
	$5\tan^2 2x-24\tan 2x+12=0 \Rightarrow \tan 2x=\frac{12\pm 2\sqrt{21}}{5}\left(4.23,\ 0.57\right)$ $\Rightarrow x=\ldots$	**dd**M1
	$x=$ awrt 3.81	A1